FY2003 Performance (scoring criterion)

As we did not present a talk in this panel last year, we defined our own goals for FY 2003.

- FY2003 Plans: To compare and contrast the structural properties of HTS films on crystal and IBAD MgO substrates
  - ✓ Structural properties of thin and thick YBCO films on crystal MgO were investigated using x-ray reflectivity, x-ray reciprocal lattice mapping, STM, RBS ion channeling, and TEM.
  - ✓ YBCO thick films on IBAD MgO have performance as good as the films on crystal substrate.
  - ✓ RBS ion channeling was for the first time used to study the crystallinity of YBCO films on polycrystalline substrate.
  - ✓ The difference of the structural properties of thick YBCO films on both crystal and IBAD MgO was identified.

FY2003 Performance (scoring criterion)

- FY2003 Plans: To compare and contrast the field and angular dependence of supercurrent of YBCO films on both crystal and IBAD MgO substrates

  - ✓ 9 PLD YBCO films with different thickness on IBAD MgO and crystal $SrTiO_3$ and MgO substrates were studied.
  - ✓ The sources of vortex pinning and the various angular regimes were identified.
  - ✓ Measurements in the temperature range 64 K < T < 75 K (pumped liquid N) and at 26.5 K (liquid Ne) and 85 K (liquid Ar) were performed.
  - ✓ Measurements in magnetic fields up to 18 T were performed at the NHMFL.

FY2003 Performance (scoring criterion)

- FY2003 Plans: To measure the thickness dependence of supercurrent of YBCO films on both crystal and IBAD MgO substrates

  - ✓ Systematic studies were carried out for YBCO films with different thickness on crystal $SrTiO_3$ and MgO substrates
  - ✓ Thick YBCO films with performance as good as the films on crystal substrates were demonstrated.
  - ✓ Depth profile of current of high quality coated conductors were investigated using ion milling experiment.
  - ✓ For the first time, we showed that J_c *vs*. thickness of ion-milled YBCO films on IBAD MgO followed the same trend as in as-deposited films.

Research Integration (scoring criterion)

- Collaboration with National Laboratory
  - ⇒ Collaborated with Vic Maroni at ANL to study the miscrostructural properties of RE123 films

    Publications: Appl. Phys. Lett. and Physica C
- Collaboration with Universities
  - ⇒ Collaborated with Prof. Pan at Univ. of Michigan and Prof. Lu at New Mexico Tech to study the microstructure for flux pinning
  - ⇒ Collaborated with Prof. Hellman at Univ. of California/San Diego to study flux pinning
  - ⇒ Collaborated with Prof. Kwon at California State Univ. /Long Beach to study defects in coated conductors
  - ⇒ Collaborated with Prof. MacManus-Driscoll to study other RE123 materials

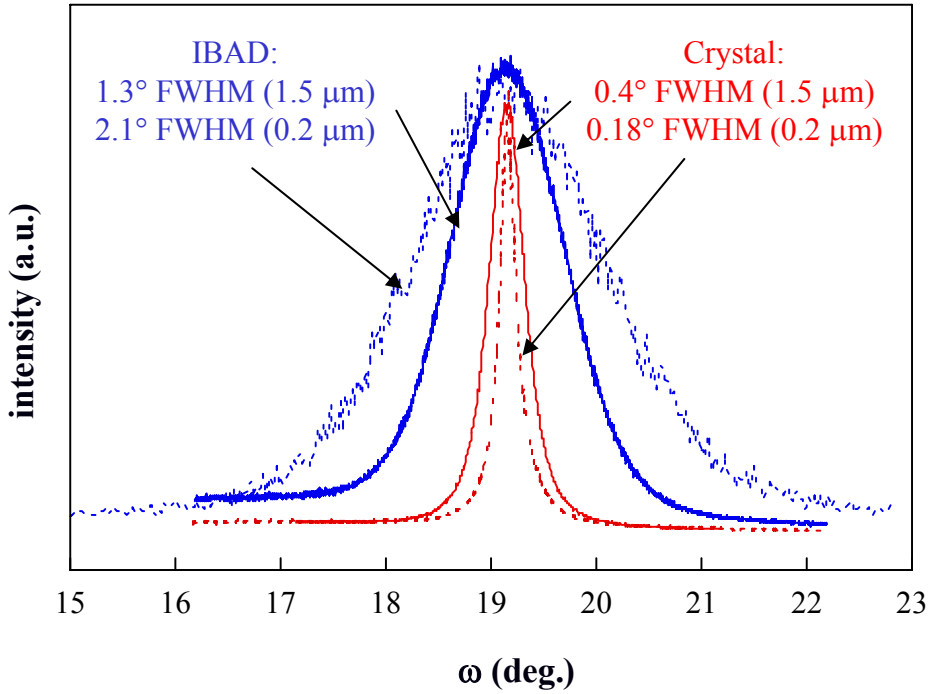
    Publications: Appl. Phys. Lett., J. Mater. Res., Rev. Scientific. Instrument, IEEE Trans. Appl. Supercond.
- Collaboration with Industry
  - ⇒ Measured field and angular dependence for multiple samples for American Superconductor.
  - ⇒ Measured field and angular dependence for multiple samples for SuperPower.

FY2003 Results (scoring criterion)

- A value of χ_{min} 65%, determined from RBS ion channeling, was for the first time tested for a YBCO film on polycrystalline substrate.
- YBCO films with a thickness in the range of 0.5 – 5 μm were deposited and had performance as good as the films on crystal substrate.

FY2003 Results (scoring criterion)

- The in-plane misalignment of YBCO on IBAD MgO (~2.3° FWHM) was approaching the value (1.4 – 1.7° FWHM) of the film on crystal MgO.
- The main structural difference of thin and thick YBCO films on crystal and IBAD MgO was identified to be the out-the-plane misalignment.

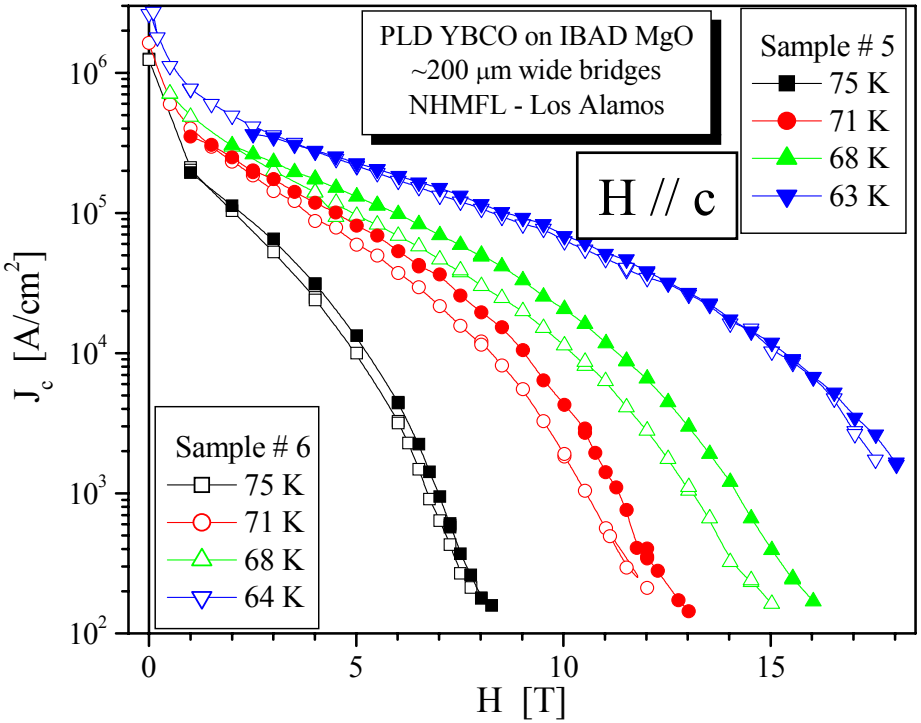


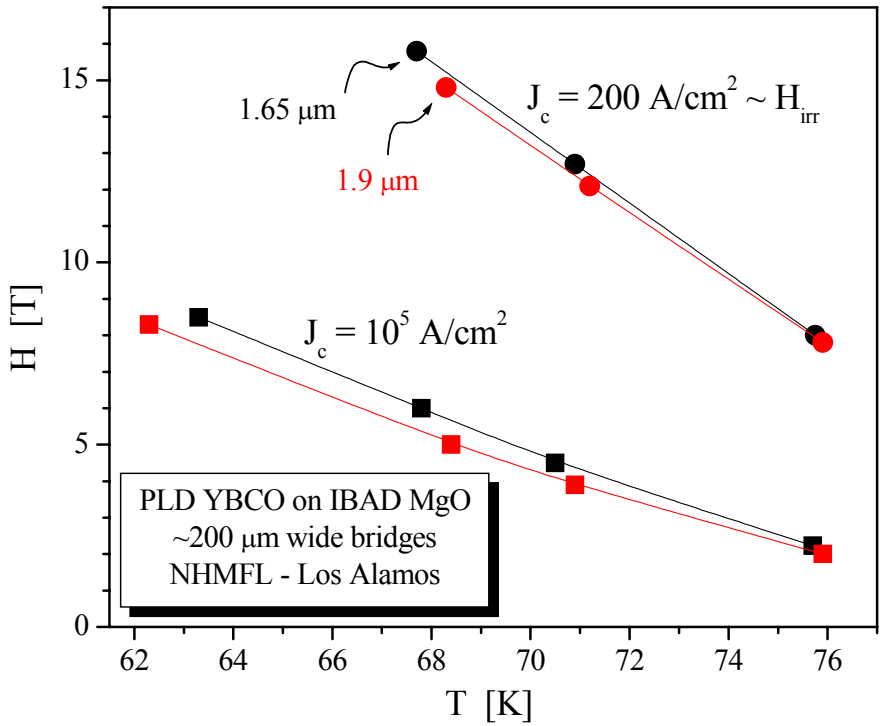
FY2003 Results (scoring criterion)

- PLD YBCO films with different thickness on IBAD MgO and crystal $SrTiO_3$ and MgO substrates were studied.
- Overall angular dependence at 75 K is similar for all films.
- The sources of vortex pinning and several angular regimes were identified.
- The angular dependence of the random defects contribution to J_c can be described using an anisotropic scaling approach.
- The c axis peak was characterized: both its angular width and normalized amplitude follow a universal field dependence for PLD YBCO.
- An additional ab plane peak due to intrinsic pinning appears in all samples. The peak sharpens as the out-of-plane texture of the film ($\Delta\omega$) decreases.

Results (scoring criterion)

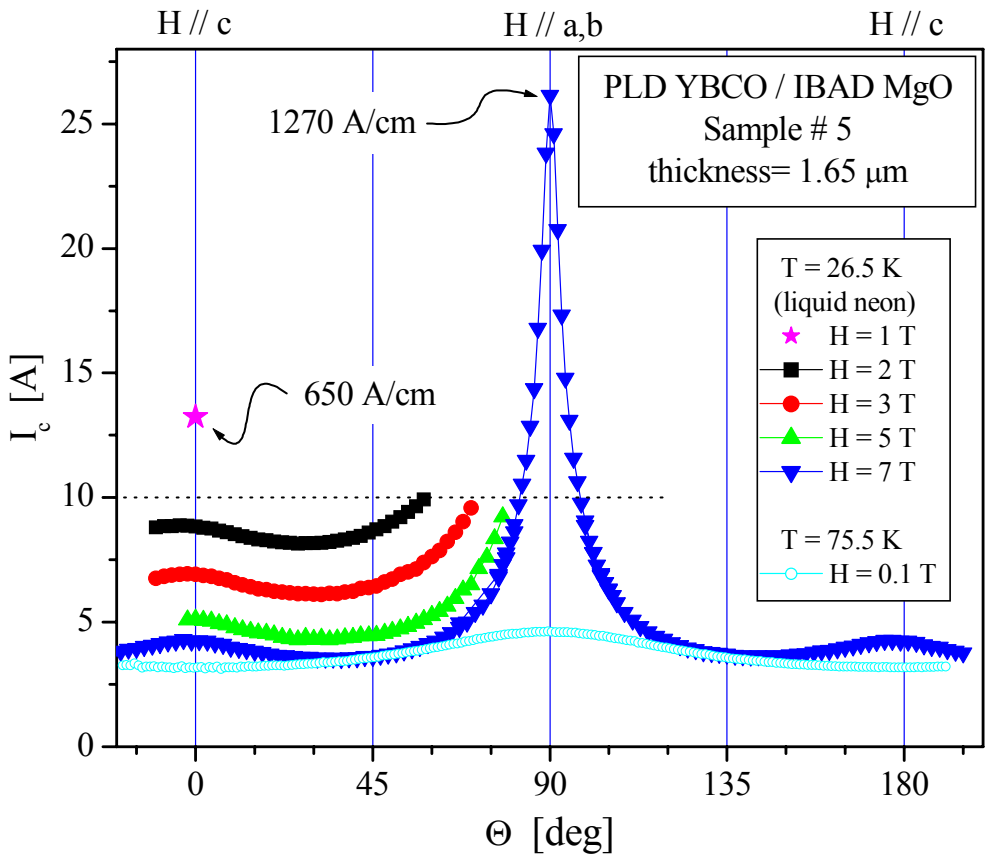
- Measurements at the NHMFL: Big improvement of in-field J_c at T ~ 64 K





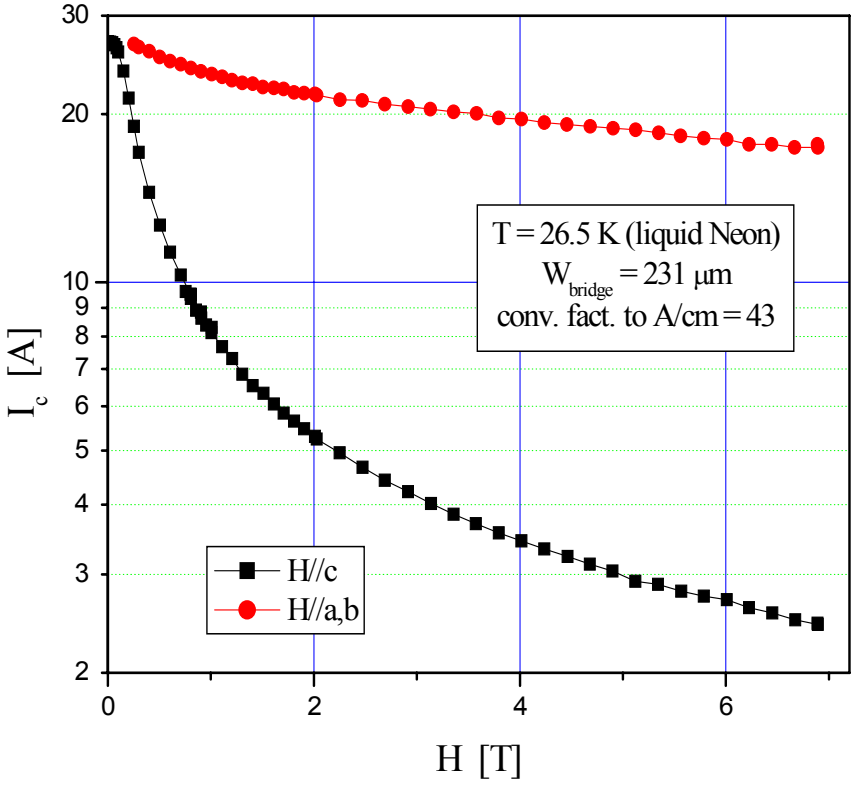
Results (scoring criterion)

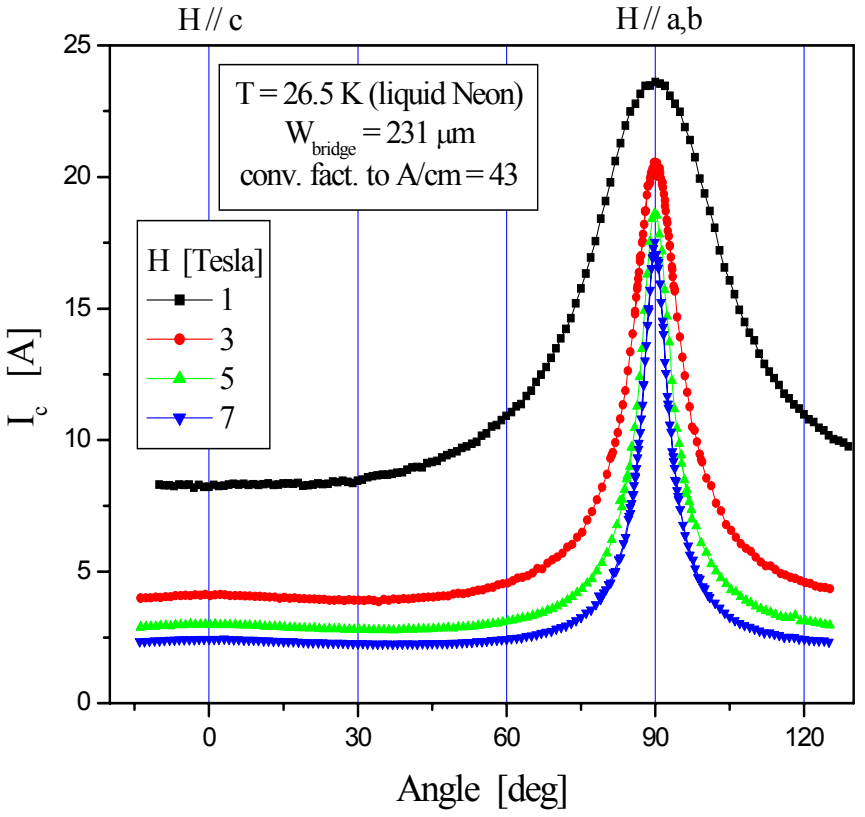
- Angular dependent measurements at lower temperatures



Results (scoring criterion)

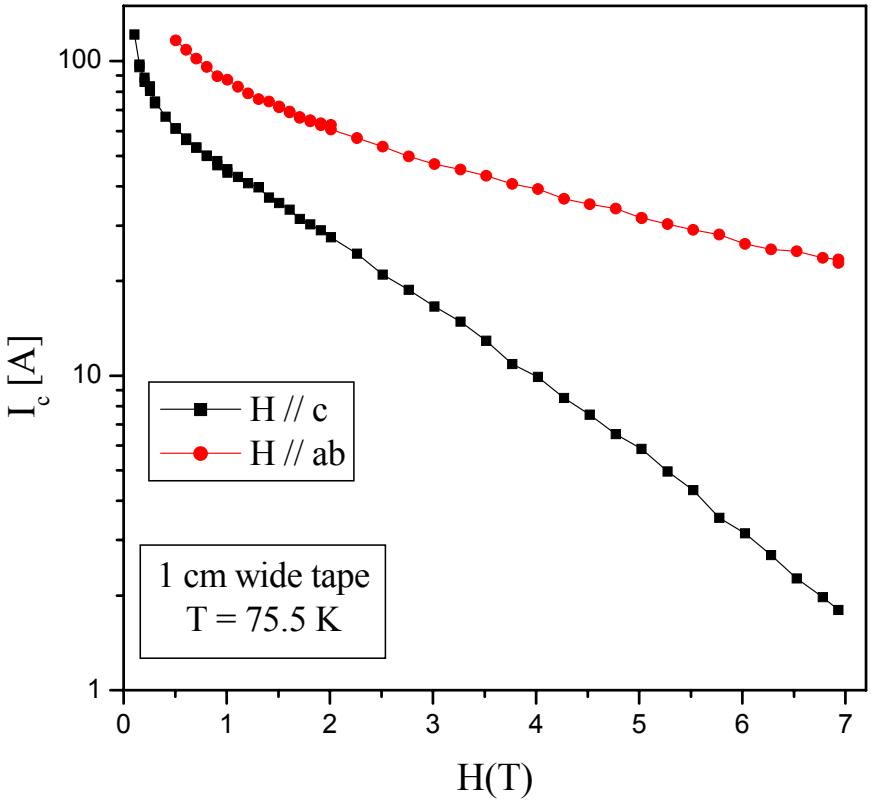
- Measured temperature, field and angular dependence for several CC fabricated by American Superconductor

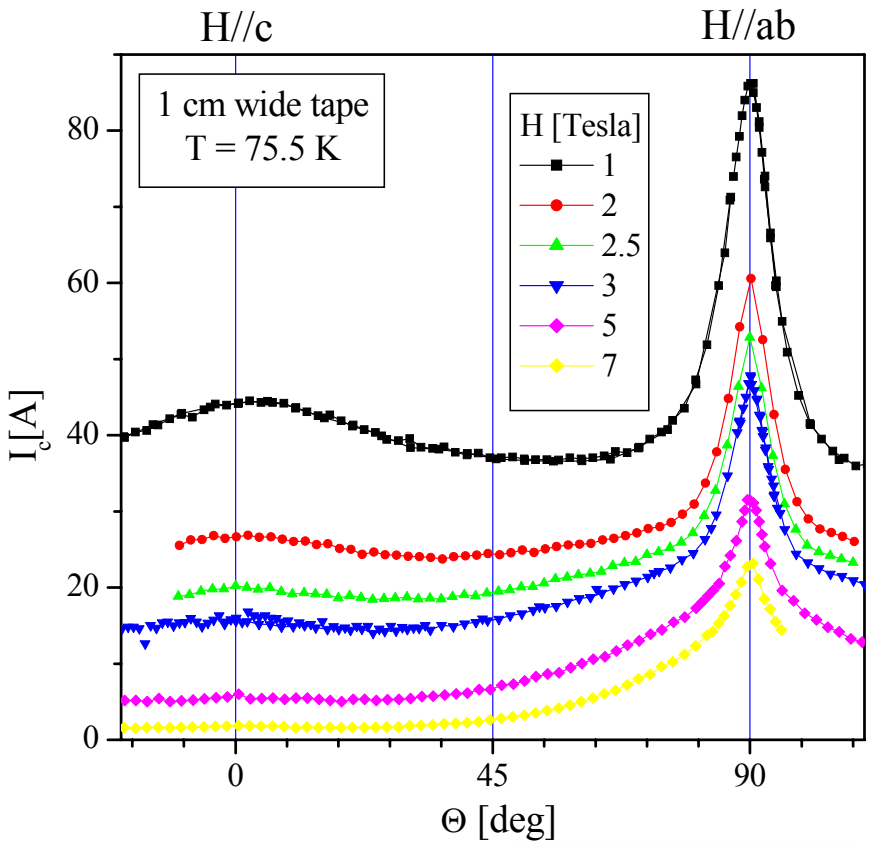




Results (scoring criterion)

- Measured temperature, field and angular dependence for several CC fabricated by SuperPower





FY2004 Plans (scoring criterion)

- To extend transport measurements and analysis to lower temperatures. *Goal: to identify pinning sources and angular regimes in the temperature range 75 K < T < 26 K (liquid Ne).*
- To extend the study to films thinner than 1 μm. *Goal: to determine whether the main pinning sources in those films with J_c > 4 MA/cm^2 are still the same.*
- To explore the angular dependence of J_c in CC with different architectures. *Goal: to determine how the relative importance of the pinning mechanisms identified in IBAD MgO changes depending on the microstructure.*
- To perform J_c measurements with current flowing in different directions in the plane. *Goal: to explore the in-plane anisotropy of the c axis correlated disorder, to determine whether the defects are linear or planar.*
- To grow HTS films with rare earth substitutions. *Goal: to search for pinning enhancements by introduction of random defects.*
- To introduce columnar defects at different angles in YBCO films on single crystal substrates. *Goal: to measure angular dependence of J_c in samples with a controlled defect structure, for comparison with the CC.*